(12) UK Patent Application (19) GB (11) 2 191 873 (13) A

(43) Application published 23 Dec 1987

(21) Application No 8713640

(22) Date of filing 11 Jun 1987

(30) Priority data
(31) 3620368 (32) 18 Jun 1986 (33) DE

(71) Applicant
Carl-Zeiss-Stiftung

(Incorporated in FR Germany)

Schott Glaswerke, D-6500 Mainz, Hattenbergstrasse 10, Federal Republic of Germany

(72) Inventors
Gerhard Bernsee
Dr Emil Körber
Dr Wolfgang Siefert

(74) Agent and/or Address for Service
Marks & Clerk,
Alpha Tower, Suffolk Street Queensway, Birmingham B1 1TT

(51) INT CL[4]
G02B 6/00

(52) Domestic classification (Edition I):
G2J G10 G9 GEA

(56) Documents cited
GB 1595163 GB 1556046 US 3681164

(58) Field of search
G2J
Selected US specifications from IPC sub-class G02B

(54) Fibre-optic light guide which is resistant to high temperatures in its end-face region

(57) A fibre-optic light guide which is resistant to high temperatures in its end-face region, comprises one end of a bundle of optical fibres 1 and a glass tube portion 4 fused onto this end, the end face 5 being polished. The fibre-optic light guide is distinguished by the fact that both the glass tube portion 4 and the bundle of optical fibres 1 consist of glass that is resistant to high temperatures and the tube portion 4 is so shrunk onto the bundle of optical fibres 1 over a defined length that the gaps between the individual optical fibres 1, and/or between the optical fibres 1 and the tube portion 4 are at least partially filled by the material of the glass tube portion 4 and/or by the material of the optical fibre sleeves 6.

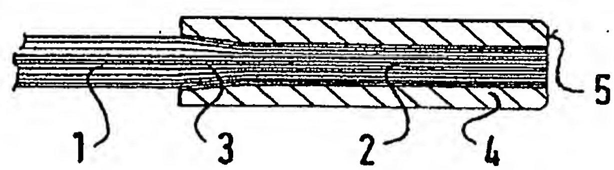

FIG. 1

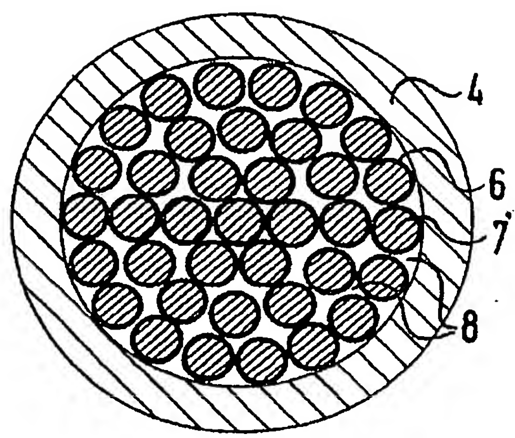

FIG. 2a

GB 2 191 873 A

SPECIFICATION

Fibre-optic light guide which is resistant to high temperatures in its end-face region, and process for its manufacture.

This invention relates to a fibre-optic light guide which is resistant to high temperatures in its end-face region, the end-face region comprising one end of a bundle of optical fibres and a glass tube portion fused onto this end and the end face being polished.

Fibre-optic light guides and probes are used in many areas of the technology relating to the transmission of optical measuring signals. Temperature-resistant flexible fibre-optic light guides are used, for example, in pyrometers, in the processing of measuring signals in high-temperature chambers and in light transmission using high-power light sources. The use of flexible fibre-optic light guides has hitherto been restricted to temperatures of up to 300°C, since the preparation of the ends possible hitherto did not allow higher temperatures.

From GB-PS 15 56 046 and DE-OS 26 30 730, it is known to seal each end of a bundle of optical fibres into a sleeve using a meltable material. In this case, however, the sealing material serves only for centering and coupling light guide cables for opto-electronic transmission systems: no attempt has been made to adapt the light guide for use at high temperatures.

From DE-PS 32 47 500, it is known to render the light guides temperature-resistant by using appropriate materials. In this case the materials used are so selected that the entire system comprising sleeve, sealing material and optical fibres is under compressive strain over the entire range of temperatures in question. This is achieved by so selecting the materials that they have a coefficient of linear expansion that decreases from outside inwards.

Owing to the temperature load, it is preferable to use those sleeve materials that are resistant to corrosion, such as, for example, high-alloy chrome-nickel steels. As a result of the high thermal expansion of these steels and the fusion between the mould and the sealing material, axial tensile stresses occur in the sealed system which may result in the formation of cracks, that is to say the destruction of the light guide.

It has also already been suggested that the ends of bundles of optical fibres be prepared by combining the optical fibres in a sleeve and gluing the individual fibres with a suitable adhesive.

Depending on the preparation of the end of the light guide, it can be exposed to different maximum temperatures. The ends of bundles of optical fibres fixed by gluing can be exposed to a maximum temperature of 150°C and those that have been prepared by fusing can be subjected to a maximum temperature of 300°C.

The problem of the invention is to develop a new fibre-optic light guide that is resistant to high temperatures in its end-face region, the end-face region comprising one end of a bundle of optical fibres and a glass tube portion fused onto this end, and the end face being polished.

The new light guide is to be formed in such a manner that it can be used at temperatures of up to 550°C.

In addition, a process for manufacturing this light guide is to be made available.

According to the invention,this problem is solved-by a light guide which is characterised in that both the glass tube portion and the bundle of optical fibres consist of glass that is resistant to high temperatures and the tube portion is so shrunk onto the bundle of optical fibres over a defined length that the gaps between the individual optical fibres and/or between the optical fibres and the tube portion are at least partially filled by the material of the glass tube portion and/or by the material of the optical fibre sleeves.

The process according to the invention is characterised in that a bundle of optical fibres that are resistant to high temperatures is arranged in a tube portion of glass that is resistant to high temperatures and this tube portion is shrunk onto the bundle over a defined length by heating and collapsing the tube, the temperature being so selected that the gaps between the individual optical fibres and/or the gaps between the optical fibres and the tube portion are at least partially filled by the material of the glass tube portion and/or by the material of the optical fibre sleeves, and subsequently the end face is polished.

Various, preferred embodiments of the invention are the subject of the subsidiary claims.

The shrinking of the glass tube portion onto the end-face region of the bundle of optical fibres can be carried out in various manners. In the simplest case, the shrinking on takes places solely as a result of the surface tension operating during collapse.

It is also possible to bring about the shrinking of the glass tube portion onto the bundle of optical fibres by a pressure difference between the external wall of the glass tube portion and the internal wall of the glass tube portion, the pressure at the exterior of the glass tube portion being greater than in the interior of the glass tube portion; this cam be achieved, for example, by applying a vacuum to the interior of the glass tube portion.

The shrinking of the glass tube portion onto the bundle of optical fibres can be achieved also by exerting a mechanical pressure externally on the glass tube portion to be treated.

In order to bring about the heating of the glass tube portion and the optical fibres ar-

ranged therein that is necessary for the shrinking operation and the fusing of the optical fibres, the glass tube portion can be heated externally using a burner, for example an H_2/O_2 burner, or using a furnace, for example a resistance-heated tubular furnace.

According to a further variant of the invention, the glass tube portion is heated by the effect of microwave irradiation.

For shrinking on while collapsing and fusing the optical fibres both to one another and to the glass tube portion, a temperature is required that lies within the softening range of the glass tube portion and the material of the fibre sleeve.

By suitably selecting this temperature and the duration of heating, it is possible to control whether the optical fibres in the end-face region fuse partially or completely.

The optical fibres used according to the invention consist of silica glass and/or doped silica glass and the glass tube portion shrunk onto these optical fibres consists likewise of silica glass and/or doped silica glass.

A further variant provides as materials for the optical fibres multi-component glasses that are resistant to high temperatures; in this case a multi-component glass is used also for the glass tube portion.

In the usual execution of the process according to the invention, the glass tube portion is shrunk onto one end of the bundle of optical fibres.

An economically especially interesting variant of the present invention provides that the shrinking on of the glass tube portion occurs approximately in the middle between the two ends of the bundle of optical fibres. The shrunk on glass tube portion is then separated approximately at its centre at right-angles to the axis of the bundle, there being obtained two light guides according to the invention that are resistant to high temperatures in their end-face region.

Examples of embodiments of the invention are explained in detail below with reference to the drawings.

Figure 1 shows a longitudinal section through the light guide according to the invention adjacent the fixed end;

Figure 2 shows a cross-section through the light guide according to the invention in the end-face region,

a) before the shrinking on of the tube portion

b) after the shrinking on of the tube portion with partial fusion, and

c) after the shrinking on of the tube portion with complete fusion.

Figures 1 shows the end of the light guide according to the invention in the region of the fixed end; the individual optical fibres of the fibre bundle 1 in the shrunk-on tube portion 4 are fused to one another and to the tube portion 4 within the region 2. The end face 5 of the fixed optical fibre bundle 1 is polished. In the transition region 3, the optical fibres are no longer completely fixed.

Figure 2*a* shows a cross-section (diagrammatic) through the light guide according to the invention in the end-face region before shrinking on of the tube portion. The individual fibres, each comprising a fibre core 7 and a fibre sleeve 6, of the optical fibre bundle 1 are arranged inside the tube portion 4 and their fibre sleeves touch or are very close at their external surfaces in the longitudinal direction and the fibres lying on the outer circumference of the bundles face the internal wall of the glass tube portion 4. The gaps 8 are the cavities running longitudinally between the individual optical fibres and between the optical fibres and the glass tube portion.

Figure 2*b* shows a cross-section (diagrammatic) through the light guide according to the invention in the end-face region after shrinking on of the glass tube portion with partial fusing. During the partial fusing, the optical fibres are fused together at the fusing places 9 over the entire length of the glass tube portion, each fibre being fused to the next fibre and the fibres on the outer circumference of the bundle being fused also to the internal wall of the glass tube portion. The fusing places correspond approximately to the position at which, before fusing, the fibres touched or were closest.

Figure 2*c* shows a cross-section through the light guide according to the invention after shrinking on of the glass tube portion with complete fusing. As a result of complete fusing, the gaps 8 between the individual optical fibres and between the optical fibres and the glass tube portion before complete fusion are completely filled by the material of the optical fibre sleeve 6 and the glass tube portion 4.

As a result of the shrinking on operation and the complete fusion, the area of cross-section of the light guide according to the invention is reduced by approximately 15 % with respect to the area of cross-section of the arrangement shown in Figure 2*a*.

CLAIMS

1. Fibre-optic light guide which is resistant to high temperatures in its end-face region, the end-face region comprising one end of a bundle of optical fibres and a glass tube portion fused onto this end and the end face being polished, characterised in that both the glass tube portion and the bundle of optical fibres consist of glass that is resistant to high temperatures and the tube portion is so shrunk onto the bundle of optical fibres over a defined length that the gaps between the individual optical fibres and/or between the optical fibres and the tube portion are at least partially filled by the material of the glass tube portion and/or by the material of the optical fibre sleeves.

2. Process for the manufacture of a fibre-optic light guide which is resistant to high temperatures in its end-face region, the end-face region comprising one end of a bundle of optical fibres and a glass tube portion fused onto this end and the end face being polished, characterised in that a bundle of optical fibres that are resistant to high temperatures is arranged in a tube portion of glass that is resistant to high temperatures and this tube portion is shrunk onto the bundle over a defined length by heating and collapsing the tube, the temperature being so selected that the gaps between the individual optical fibres and/or the gaps between the optical fibres and the tube portion are at least partially filled by the material of the glass tube portion and/or by the material of the optical fibre sleeves, and subsequently the end face is polished.

3. Process according to claim 2, characterised in that the optical fibres are partially fused both to one another and to the shrunk on glass tube portion in the end-face region.

4. Process according to claim 2 or 3, characterised in that the shrinking of the glass tube portion onto the bundle of optical fibres is carried out without the action of external pressure.

5. Process according to claim 2 or 3, characterised in that the shrinking of the glass tube portion onto the bundle of optical fibres is carried out by causing a pressure difference between the external wall of the glass tube portion and the internal wall of the glass tube portion, the pressure exerted on the external wall of the glass tube portion being greater than the pressure exerted on the internal wall of the glass tube portion.

6. Process according to claim 2, 3 or 5, characterised in that the shrinking of the glass tube portion onto the bundle of optical fibres is brought about by the action of an external mechanical pressure on the glass tube portion.

7. Process according to one of claims 2 to 6, characterised in that the heating of the glass tube portion is brought about by an external heating action.

8. Process according to one of claims 2 to 7, characterised in that the optical fibres and/or the glass tube portion consist of silica glass and/or doped silica glass.

9. Process according to one of claims 2 to 7, characterised in that the optical fibres and/or the glass tube portion consist of multi-component glasses that are resistant to high temperatures.

10. Process according to one of claims 2 to 9, characterised in that the shrinking on of the glass tube portion is carried out starting at one end of the bundle of optical fibres.

11. Process according to one of claims 2 to 9, characterised in that the glass tube portion is shrunk on at a place between the two ends of the bundle of optical fibres, and the shrunk on glass tube portion is separated in the middle at right-angles to the axis of the bundle so that two fibre-optic light guides that are resistant to high temperatures in their end-face regions are formed.

12. A fibre-optic light guide as claimed in claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

13. A process as claimed in claim 2, substantially as hereinbefore described with reference to the accompanying drawings.

14. A fibre-optic light guide when manufactured by a process as claimed in any one of claims 2 to 11 or claim 13.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon) Ltd, Dd 8891685, 1987. Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

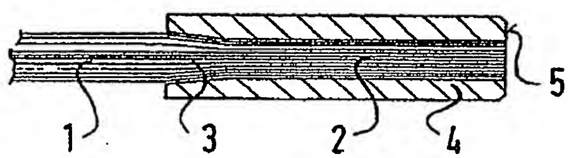

FIG. 1

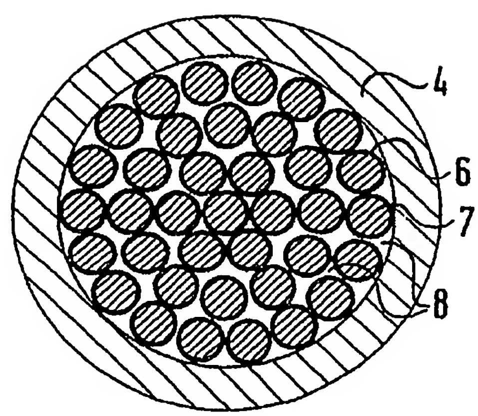

FIG. 2a

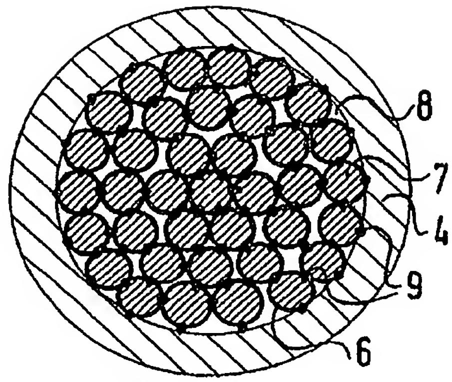

FIG. 2b

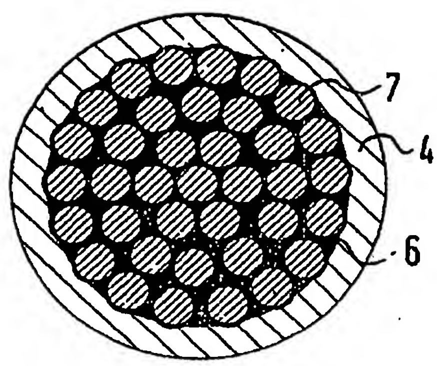

FIG. 2c